

## ABSTRACT

Apparatus and processes are disclosed for milling copper adjacent to organic low-k dielectric on a substrate by directing a charged-particle beam at a portion of the copper and exposing the copper to a precursor sufficient to enhance removal of the copper relative to removal of the dielectric, wherein the precursor contains an oxidizing agent, has a high sticking coefficient and a long residence time on the copper, contains atoms of at least one of carbon and silicon in amount sufficient to stop oxidation of the dielectric, and contains no atoms of chlorine, bromine or iodine. In one embodiment, the precursor comprises at least one of the group consisting of NitroEthanol, NitroEthane, NitroPropane, NitroMethane, compounds based on silazane such as HexaMethylCycloTriSilazane, and compounds based on siloxane such as Octa-Methyl-Cyclo-Tetra-Siloxane. Products of the processes are also disclosed.